

UNIVERSITY OF CALIFORNIA EXTENSION,
SANTA BARBARA

VOLUME IX, NUMBER 9, MARCH 1981 (USPS 128-070)

UCSB EXTENSION is published twenty-eight times a year, two times in January and December; three times in March, June, September, November; four times in February, May, August; and no issues in April, July and October. Published by University of California Extension, University of California, Santa Barbara, California 93106. Second class postage paid at Santa Barbara, CA. Sent free of charge to those desiring information of University Extension activities.

The University of California, in compliance with Titles VI and VII and the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972 (45 CFR 86), and Sections 503 and 504 of the Rehabilitation Act of 1973, does not discriminate on the basis of race, color, national origin, religion, sex, or handicap in any of its policies, procedures, or practices, nor does the University, in compliance with the Age Discrimination in Employment Act of 1967 and Section 402 of the Vietnam Era Veterans Readjustment Act of 1974, discriminate against any employees or applicants for employment on the basis of their age or because they are disabled veterans or veterans of the Vietnam era. This nondiscrimination policy covers admission, access, and treatment in University programs and activities, and application for and treatment in University employment.

In conformance with University policy and pursuant to Executive Orders 11246 and 11375, Section 503 of the Rehabilitation Act of 1973, and Section 402 of the Vietnam Era Veterans Readjustment Act of 1974, the University of California is an affirmative action/equal opportunity employer.

Inquiries regarding the University's equal opportunity policies may be directed to Raymond Huerta, Affirmative Action Coordinator, at (805) 961-2089.

All of the information requested on the application form with the exception of the social security number is required for processing registration in University Extension courses and for future correspondence with applicants. Without the information, University Extension cannot register you in any of its courses. When appropriate, the information will be available for inspection by state or federal agencies. The Director of University Extension, 1833 Ellison Hall, UCSB, (805) 961-2944, maintains the requested information. You have a right to inspect University records containing the personal information requested on this form.

Disclosure of your social security number is voluntary. The Extension record-keeping system was established pursuant to the authority of The Regents of the University of California under Art. IX, Sec. 9 of the California Constitution. The security number is used to verify your identity.

ENROLLMENT APPLICATION

MAIL TO: University of California Extension, Santa Barbara, CA 93106

MAKE ALL CHECKS PAYABLE TO: The Regents of the University of California

Social Security Number		Daytime Phone	
First Name	Middle Initial	Last Name	
Mailing Address		Street	
City	State	Zip	
PLEASE CHECK ONE:	☐ Fiber Optics X457	EDP 11047	FEE: \$550
	☐ Detection of I.R. X449	EDP 11048	FEE: \$550

- ☐ Please send me off-campus housing information.
- ☐ I wish to stay on-campus in a ☐ single, ☐ double room.

Amount enclosed to cover cost of housing: \$ _____

A B C D E

969

G 07870
T NELSON
SYST CONS
BOX 3
SCHOOLEYS MTN NJ 07870

2 Engineering Short Courses
to be held On-Campus in Santa Barbara

M 81

FIBER OPTIC
COMMUNICATION
SYSTEMS

JULY 13-17, 1981

DETECTION
OF INFRARED
RADIATION

JULY 27-31, 1981



UNIVERSITY OF
CALIFORNIA EXTENSION
SANTA BARBARA

ucsb extension



Encircled by picturesque mountains and miles of natural beaches, Santa Barbara offers the perfect summer climate for study and relaxation. Take advantage of the low-cost on campus housing while you attend these highly rated and widely recognized engineering short courses held on the beautiful Santa Barbara campus of the University of California. An impressive array of experts has been assembled to provide the latest state of the art information in these fields. See below and inside for details.

FIBER OPTIC COMMUNICATION SYSTEMS

FACULTY

COURSE COORDINATOR: **DR. MICHAEL K. BARNOSKI**, Director, Technology Research Center, TRW, El Segundo, California.

Dr. Barnoski directs the Technology Research Center for TRW Electronics. He is responsible for establishing new technology programs in areas of interest to TRW and for operating management of the research center. Prior to joining TRW in August of 1979, Dr. Barnoski spent 10 years at Hughes Research Laboratories as a researcher and manager of the optical circuits department with responsibility for managing research and development in optical circuits. Dr. Barnoski has broad experience in solid state physics, microwave electronics and circuit theory, quantum electronics, semiconductor device physics, and integrated and fiber optics.

DR. J.E. GOELL, President and Chief Executive Officer, Lightwave Technologies, Inc., Los Angeles, California.

Dr. Goell directed the ITT fiber optics program in Roanoke. Formerly, he worked on solid-state repeaters for millimeter-wave communication systems and optical integrated circuits at Bell Telephone Laboratories.

DR. DONALD B. KECK, Manager, Applied Physics Department, Corning Glass Works, Corning, New York.

His major interest is in the area of research on optical waveguides. This includes attenuation studies on both

single and multimode waveguides and general propagation studies in multimode structures.

DR. HENRY KRESSEL, Staff Vice President, RCA, Princeton, New Jersey.

He pioneered in the field of (AlGa) As-GaAs heterojunction devices, in particular laser diodes. He is recipient of three RCA achievement awards as well as a 1974 David Sarnoff Award for Outstanding Technical Achievement, RCA's highest award.

DR. STU PERSONICK, Director Opto Electronic Systems Laboratory, Technology Research Center, TRW, El Segundo, California.

From April 1978-January 1981 he was responsible for the development of digital telephone transmission and switching equipment at TRW/Vidar division. In February 1981 he joined the TRW Technology Research Center and is responsible for the development of optical systems and subsystems.

DR. HENRY F. TAYLOR, Branch Head, Optical Sciences Division, Naval Research Laboratory, Washington, D.C.

His primary research interest during the past several years has been in the areas of fiber optic signal transmission and integrated optics. He was formerly with the Near Infrared Devices Group of Rockwell International Science Center in Thousand Oaks, California and the Naval Ocean Systems Center in San Diego.

DETECTION OF INFRARED RADIATION

FACULTY

COURSE COORDINATOR: **DR. MICHAEL K. BARNOSKI**, (See Fiber Optic Communication Systems)

DR. DEAN BAKER, Manager, Special Projects, Northrop Research and Technology Center, Palos Verdes, California.

He has mostly been involved in electron device physics and applications. His current interests center on charge coupled devices for infrared and signal processing applications.

LLOYD H. DEVAUX, Senior Staff Physicist, Hughes Research Laboratories, Malibu, California.

He is currently working on crystal gamma detector development and intrinsic photoconductors, avalanche effects in photodiodes, and alloy semi-conductors. Developed high performance indium antimonide photovoltaic and photoconductive detectors now used extensively in military infrared systems.

FRANCIS E. GOODWIN, Manager, Advanced Systems Department, Space and Communications Group, Hughes Aircraft, Los Angeles, California.

He has conducted extensive applied research. His work led to the demonstration of optical heterodyne communication systems at 10.6 and 3.39 μm .

PROF. HENRY LEVINSTEIN, Professor of Physics, Syracuse University, New York.

His main interest is with the physical properties of infrared detector materials. Developed several types of detector materials and detector testing techniques. He has published numerous papers in the field. Professor Levinstein has served as Chairman of the New York State Section of the American Physical Society, of the Detector Specialty Group of IRIS, and of the executive committee of the Third International Photoconductivity Conference. He is a consultant and advisor for industry and government on IR detectors and detector materials.

DR. A.F. MILTON, Branch Head, Optical Warfare Branch, Naval Research Laboratories, Washington, D.C.

He has a broad background in infrared detection and infrared systems. Prior to joining NRL he was in the science technology division at the Institute for Defense Analysis (IDA).

PROF. W.E. SPICER, Professor of Electrical Engineering and Materials Science, Stanford University, Stanford, California.

His major interests are in surface physics especially as applies to negative electron affinity photocathodes and U.V. photo emission spectroscopy. Prior to joining the faculty at Stanford he was employed by RCA Research Laboratories where he investigated the physics of practical photo cathodes.

FIBER OPTIC COMMUNICATION SYSTEMS

This program provides a tutorial review of the fiber optic technology as applied to communications systems. Emphasis is placed on practical system design with tutorial review of the important aspects of each component in the system. Detailed consideration will be given to optoelectronic sources, optical fibers, photodetectors, receiver circuit design, repeaters, propagation characteristics, dispersion, equalization, fiber cabling, connectors, data distribution, anticipated applications, system trade-off analysis and design.

PROGRAM SCHEDULE

MONDAY, JULY 13

Morning

FUNDAMENTALS OF OPTICAL FIBER WAVEGUIDES — DR. D. KECK

Basic description of materials and techniques for fabrication of optical fibers; doped deposited silica techniques, double crucible technique, technique for drawing preforms into fibers. Comparison of fibers resulting from each technique, types of fiber materials; low loss silica, glasses, plastic materials. Numerical aperture, geometrical tolerances, mechanical properties, radiation effects, environmental effects. State of the art review; characteristics of various types of commercially available fibers, results on research fibers.

Afternoon

COUPLING CONSIDERATIONS — DR. M.K. BARNOSKI

Analysis of input coupling losses for LED and laser sources, law of brightness, splices and connectors. Component selection and system power budgets.

5:00pm — *Get acquainted*

BEACH BARBECUE

TUESDAY, JULY 14

Morning

PROPAGATION IN MULTIMODE WAVEGUIDES — DR. D. KECK

Information capacity, pulse broadening in single mode fibers, pulse broadening in step and graded fibers, material dispersion, modal dispersion and attenuation. Mode coupling effects. Effects of bends. Physical insight will be provided for the results predicted by modal propagation theory, comparison to experimental

Afternoon

ELECTRO-LUMINESCENT SOURCES FOR FIBER SYSTEMS — DR. H. KRESSEL

Brief tutorial review of the physics of p-n junctions, light-emitting diodes, injection lasers. Review of various material systems and their corresponding emission wave-lengths. Consideration will also be given to pertinent device parameters such as optical output power, operating life, drive currents, modulation rate, goniometric characteristics (angular optical power distribution, emission geometries, planar edge emitter, point emitter, strip), operating wavelength, spectral width, spectral stability, linearity, temperature characteristics. State of the art review.

WEDNESDAY, JULY 15

Morning

PHOTODETECTION — DR. S. PERSONICK

Photodetection, p-n junctions, PIN diodes, avalanche photodiodes, equivalent circuit, noise sources, speed of response, responsivity, spectral response, linearity, geometry, noise equivalent power, noise statistics, signal to noise limited error rate.

Free Afternoon

THURSDAY, JULY 16

Morning

RECEIVER AND TRANSMITTER DESIGN — DR. S. PERSONICK

High impedance amplifiers (FET, bipolar), equalization, inter-symbol interference, eye diagrams, dispersion limited data rates, signal-to-noise limited data rates, receiver circuit components, source drive circuitry, optimum optical pulse shape. Modulation formats.

Afternoon

PASSIVE COMPONENTS — DR. M.K. BARNOSKI

Data distribution network components, Tee couplers, star couplers, duplex couplers. Power budgets and design tradeoff for data distribution networks.

FRIDAY, JULY 17

Morning

OPTICAL FIBER SYSTEMS TRANSMISSION CONSIDERATIONS — DR. J. GOELL

Hardware available, hardware implementation, electronics, specific example systems, review of commercial field trials, military applications.

Afternoon

REVIEW OF SINGLE MODE TECHNOLOGY — DR. H. TAYLOR

State of the art in single mode fibers, switches, modulators, injection lasers. Applications, communications, processing.

Course Details

Enrollment is requested by June 29. On-campus housing is available. See Enrollment and Housing Information for details.

LOCATION: Rm. 1104, Engineering Bldg., University of California, Santa Barbara.

TIMES: Mon., Tues., & Thurs., 9am-4pm; Wed. 9am-12 noon; Fri. 9am-3pm, July 13-17, 1981.

COURSE NUMBER: X457

EDP 11049 / CREDIT: 3 units

FEE: \$550 (includes parking, text and materials)



ENROLLMENT AND HOUSING INFORMATION

Early enrollment is advised. Registration is requested by the date shown for each class. To request space after this date, call (805) 961-4143 or 961-3697. No refunds will be granted after this date unless the program is cancelled. Reservations will be accepted for industry and government employees if an official letter indicating attendance and a completed enrollment application are received prior to the requested date. In this case, fees for tuition and on-campus housing may be hand-delivered at the opening of the program. Otherwise, they should accompany the enrollment application.

A package plan for on-campus housing in twin-bedded dormitory rooms is available for \$165 for single occupancy and \$150 for double occupancy rooms for the week. The plan includes three meals daily, served cafeteria style, beginning with dinner on Sunday and ending with lunch on Friday. There are no weekend extensions on housing or meals. Spouses and children age 12 and over may accompany participants staying on campus. The double rate applies to two individuals booking a room together or participants accompanied by their spouses and children. We cannot make room assignments for single individuals requesting the double rate. Complete details on meal times, location of rooms, a campus map, and other general information will be sent upon receipt of enrollment.

If you prefer to stay off-campus, literature on hotel-motel accommodations is available upon request (see enrollment application).

DETECTION OF INFRARED RADIATION

This course is designed to provide a review of the basic properties of various infrared detection mechanisms along with the most recent advances in infrared detectors and their systems applications. Device physics, performance and system applications will be stressed. Detailed aspects of thermal and photon detectors will be considered along with photomission in infrared. Full analysis will include both detection and noise mechanisms. Normal heterodyne modes will be considered. Considerations also will be given to electronic receiver design and measurement techniques. In addition, the utilization of charge coupled devices in thermal imaging systems will be treated. Treatment will also be given to infrared systems and detector performance criteria.

PROGRAM SCHEDULE

MONDAY, JULY 27

Morning

INTRODUCTION — PROF. H. LEVINSTEIN

Phenomenological description of infrared detection. Basic infrared detectors, photo effects (internal-photoconductive; external-photoelectric), thermal effects. Figures of merit (definitions), D , D^* , NEP's.

GENERAL TREATMENT OF IR DETECTORS I — DR. M. BARNOSKI

Review of semiconductor physics. Rate equations for photon and thermal detectors.

Afternoon

GENERAL TREATMENT OF IR DETECTORS II — DR. M. BARNOSKI

Photo effects on p-n junctions. Analysis of thermal detection mechanisms, bolometers, thermocouples, thermopiles, pyroelectric effect. Noise mechanisms in IR detectors. Comparison of photon and thermal detectors.

5:00pm — *Get acquainted*
BEACH BARBECUE

TUESDAY, JULY 28

Morning

PHOTON EFFECTS — MR. L. DeVAUX

Analysis of photoconductive and photovoltaic modes of infrared detection. Photon noise limitations: spectral photon noise-limited detectivity, black body photon noise-limited detectivity, effects of filtering and field of view, blip limits, techniques of achieving photon noise-limited performance. Material figures of merit. State-of-the-art review.

Afternoon

STUDENT LABORATORY SESSION — PROF. H. LEVINSTEIN

Time constant measurements, frequency response. V-I curves for thermistors, p-n junctions, student-made point contact rectifiers, photodiodes. Activation energy measurements. Thermal probes. Normalization of spectral response. D^* and responsivity measurements. Hall measurements.

WEDNESDAY, JULY 29

Morning

REVIEW OF MODERN INFRARED DETECTORS — MR. L. DeVAUX

Material parameters pertinent in detector fabrication. Intrinsic and extrinsic infrared detectors. Modes of operation. Present state of the art for InSb, HgCdTe, PbSnTe, and extrinsic silicon detectors. Comparative performance of state-of-the-art detectors. Current detector materials research.

Afternoon

CHARGE COUPLED DEVICES AND INFRARED IMAGING — DR. D. BAKER

Tutorial review of charge coupled devices. Infrared imaging using CCDs. System performance characteristics. Fabrication techniques. Current research efforts.

THURSDAY, JULY 30

Morning

DETECTORS AS A SYSTEM ELEMENT — DR. A.F. MILTON

IR imaging systems. Modulator transfer function and sampling. EYE display interface and MRTD. Choice of spectral band. Laser detection systems.

Afternoon

FOCAL PLANE DESIGN FOR IR IMAGING SYSTEMS — DR. A.F. MILTON

Detector electronics. Series vs. parallel scan. Hybrid and monolithic IR focal plane array technologies.

FRIDAY, July 31

Morning

PHOTOEMISSION IN THE INFRARED — PROF. W. SPICER

Tutorial review of photoemission: definition of problem variables, work function, photo threshold, electron affinity, parameters affecting quantum efficiency in the diffusion model. State of the art: negative electron affinity photocathodes, III-V semiconductor photoemitter base dipole layer activation. Structure for enhancement of photoemission: tunnel photocathode, biased surface barrier photocathode. Long-range prospects for efficient photoemission in the

Afternoon

HETERODYNING IN THE INFRARED — MR. F. GOODWIN

Review of theory of heterodyne operation. State of the art in heterodyne detection. Comparison of normal and heterodyne modes of operation. Criteria for using heterodyning configuration. Application to communication systems.

Course Details

Enrollment is requested by July 13.

On-campus housing is available. See Enrollment and Housing Information for details.

LOCATION: Rm. 1104, Engineering Bldg, University of California, Santa Barbara

TIMES: Mon.-Fri., 9am-4pm, July 27-31, 1981

COURSE NUMBER: X449

EDP 11048 / CREDIT: 3 units

FEE: \$550 (includes parking, and course notes)